Laboratory Equipment Manufacturer
www.mrclab.com

FREEZE DRYER
USER'S MANUAL
FD5/8-xB Series

3, Hagavish st. Israel 58817 Tel: 972 3 5595252, Fax: 972 3 5594529 mrc@mrclab.com

MRC.VER.01-1.14

WARRANTY

By accepting and operating this instrument, the user and the manufacturer agree to the following responsibilities which constitute contractual warranties and conditions between the seller and the user for the maximum benefit and usefulness of the instrument.

1 WARRANTS THAT IT:

1) Has produced equipment equal to or exceeding that of any competitive product in the same price range in standards of design, material and workmanship.
2) Knows of no defects in design or materials that may cause bodily injury.
3) Will endeavor to advise the user of changes or improvements in the instrument, as they are developed, so that the user may take steps to improve the safety and performance of his equipment throughout its useful life.
4) Will replace or repair equipment according to the guarantee on the attached warranty.
5) Will cooperate closely in common defense of any accident involving this equipment, or third-party suit against the user or operating personnel, if advised immediately by the user of the occurrence of any accident.

2 THE USER WARRANTS THAT:

1) The instrument will be used reasonably.
2) The instrument will be regularly maintained according to this manual, including a log of all service, tests and repairs performed on the equipment, and records will be kept of all requests for repair made to MRC where such repairs were beyond the ability of local service personnel.
3) The instrument will not be altered without written approval from MRC.
4) MRC will be notified immediately if any injury occurs in any association with the instrument and will be allowed prompt and thorough examination of the instrument in question.
5) MRC will be held harmless in cases of injury arising (see definitions below):
   a) Beyond the useful life of the equipment.
   b) From unreasonable use.
   c) When MRC is not immediately notified of said injury.
   d) From interpretation of results.

DEFINITIONS

1. **"Useful life" is:**
   2) The same as the depreciation life in the Internal Revenue Service guidelines, whether or not the user actually depreciates the instrument, but not to exceed 10 years from the date of delivery to the user.
   3) Only during the time the equipment has been maintained on a regular basis as prescribed by MRC. If the user is in an area which has no local service, MRC may require a local service person (understood to mean the person actually performing the "hands-on" service of the equipment) to attend and pass a reasonable maintenance and repair course.
   4) Only during the time when the user has not altered the equipment in any way without written approval from MRC.
   5) Only during the time when the user has not loaned, leased or resold the equipment to any third party.

2. **"Reasonable use" is use:**
   1) According to the instructions supplied by MRC (assuming English-reading personnel or supervision). If neither the supervisor nor the operator reads English, the user agrees to obtain accurate translations of the instrument labels, instructions, user's guides and/or manuals provided.
   2) Under direct, on-the-job supervision of the supervisor or other professional in charge.
   3) In which there are no known defects or uncorrected repairs.
   4) Only for the purpose stated in the instructions provided with the instrument.
   5) In which the equipment has been maintained according to the instructions provided.

3. **"Immediate notification" is:**
   1) Recognition that time is of the essence when any accident, malpractice or product liability arises which involves MRC equipment.
   2) Notification to MRC immediately (the same day, if possible) in the event of injury to any person in circumstances involving MRC equipment in which MRC might be named as a defendant in any form of litigation.
   3) Allowing MRC or its representatives, immediate, full, and thorough examination of MRC equipment, and all records pertaining to such equipment.

Contents

WARRANTY 1
DEFINITIONS 2
Chapter 1 General Information 4
1.1 What is freeze drying (lyophilisation)? 4
1.2 How Freeze Dryer Works? 4
1.3 Freeze Dry Rates 5
1.4 Freeze Dry Capacity 6
1.5 Samples Containing Volatile Substances 6
Chapter 2 Safety Instruction 7
2.1 Disconnect the mains plug! 7
2.2 CAUTION! Solvents! 7
2.3 ADVICE! Cleaning and Maintenance of the Unit! 7
2.4 WARNING! Freezing of limbs to surfaces! 7
2.5 Forbidden freeze drying process 8
2.6 Important Notes 8
Chapter 3 Shipments 10
3.1 Choose a correct installation location 10
3.2 Unpack your freeze dryer 10
3.3 Transport Instructions! 11
3.4 Packing List 11
Chapter 4 Getting Started 13
4.1 Checking Voltage setting 13
4.2 Installation of Key Touch Screen 14
4.3 Vacuum Pump Connection 15
4.4 Connection of clear drying chamber 19
Appendix: Chemical resistance of freeze dryer components 21
Solvent safety precautions 22
Chapter 5 Operation 23
5.1 Operation Checklist 23
5.2 Preparation: pre-freezing samples 23
5.3 Preparation: connecting accessories 24
5.4 Loading sample 25
TIPS 25
5.5 Operating the Freeze Dryer 26
5.6 How to use sealing torch 30
Chapter 6 MAINTANENCE 31
6.1 Maintenance of freeze dryer 31
6.2 Maintenance of vacuum pump 32
Chapter 7 Trouble Shooting 33
7.1 Troubleshooting 33
7.2 Before you asking for technical assistance: 34
Chapter 8 Warranty and contact information 36
8.1 International Warranty 36
8.2 Conditions and terms of sale 36
8.3 Contact information 36
Appendix A: Technical Specification 37
Appendix B: Refrigeration Drawing 38
Appendix C: Principle of Refrigeration 39
Appendix D: Vacuum System 40

Chapter 1 General Information

1.1 What is freeze drying (lyophilisation)?

Freeze-drying is a method for preserving materials, which are unstable in solution. In addition, freeze-drying can be used to separate and recover volatile substances, and to purify materials.

Freeze drying means: Extraction of water from frozen material. The drying process takes place by avoiding the liquid state through sublimation, i.e. direct conversion from ice to vapor. This happens under vacuum and the temperature inside the product is normally less than -10°C.

The aim of freeze drying is to obtain a readily water-soluble product which has the same characteristics as the original product after addition of water. As the drying process takes place in the frozen state at very low temperatures it is possible, for example, to dry proteins which will not denature. Also most of the other chemical compounds will be qualitatively and quantitatively unchanged.

Through freeze drying the product, mainly of biological origin -such as tissues, tissue extracts, bacteria, vaccines and sera – is transformed into a dry product. During this process enzymatic, bacterial and chemical changes are largely avoided. Freeze drying (lyophilisation) is the gentlest process for preserving the biological properties of sensitive tissue and tissue components. Lyophilisation is also the best method when drying inorganic products – e.g. nanoscale dispersions – the particle surfaces of which should remain unchanged.

1.2 How Freeze Dryer Works?

The fundamental process steps are:

1) **Freezing**: The product is frozen. This provides a necessary condition for low temperature drying.
2) **Vacuum:** After product is solid frozen, it is placed in a chamber, and the refrigeration system keeps on working under vacuum. This enables the frozen solvent in the product to vaporize without passing through the liquid phase-a process known as sublimation.
3) **Heat:** Heat is applied to the frozen product to accelerate sublimation.
4) **Condensation:** Low-temperature condenser removes the vaporized solvent from the vacuum chamber by converting it back to solid state. This completes the solvent separation process.

1.3 Freeze Dry Rates

The efficiency of the freeze drying process is dependent upon the surface area and the thickness of the sample, the cold trap temperature and vacuum obtained, the eutectic point and solute concentration of the sample. It is important to remember these factors when trying to obtain efficient utilization of your freeze dry system. A listing of selected materials and their approximate drying times are shown in the following table for your reference.

Table 1

SAFE TEMPERATURE AND DRYING TIMES FOR SELECTED MATERIALS			
Material 10mm Thick	Safe Temperature °C	Cold Trap Temperature °C	Hours (Approx.)
Milk	-5	-40	10
Urea	-7	-40	10
Blood Plasma	-10 to -25	-40	16
Serum	-25	-40	18
Vaccinia	-30 to -40	-50	22
Influenza Vaccine	-30	-50	24
Human Tissue	-30 to -40	-50	48
Vegetable Tissue	-50	-80	60

* Total sample quantities are contingent on various freeze dryer capacities.

Up to the point of overloading the system, the greater the surface area of the sample, the faster the rate of freeze drying. By contrast, for a given surface area, the thicker the sample is the slower the rate of freeze drying. This is based on the fact that the heat of sublimation is usually absorbed on one side of the frozen sample and must travel through the frozen layer to vaporize water at the other surface. In addition, as the sample is freeze dried, the water vapor must travel through the layer of dried material. The thicker the sample is, the greater the chance that the dried layer may collapse which would cause an additional decrease in the rate of freeze drying.

The surface area and thickness of the sample can usually be ignored when each sample contains only a few milliliters. However, for larger volumes, the samples should be shell frozen to maximize the surface area and minimize the thickness of the sample. The volume of the freeze dry flask should be two to three times the volume of the sample.

In order for lyophilization to occur, ice must be removed from the frozen sample via sublimation. This is accomplished by the cold trap and the vacuum pump. The told trap, which should be at least 15 to 20°C colder than the eutectic temperature (melting temperature) of the sample, traps vapor as ice. Since the vapor pressure at the cold trap is lower than that of the sample, the flow of water vapor is from the sample to the cold trap. Since this vapor diffusion process occurs very slowly under normal atmospheric conditions, a good vacuum is essential to maintain an efficient rate. In many applications, the maintenance of a vacuum of 0.133 mBar or less is recommended.

The rate of freeze drying is directly proportional to the vapor pressure and the vapor pressure is dependent upon both eutectic temperature and solute concentration of the sample. For example, a solution of sodium chloride and water would freeze dry at a slower rate than pure water. The eutectic temperature of a sodium chloride solution is about -20°C and at this temperature the vapor pressure is about 1/16 that of water at 0°C. Although the eutectic temperature is not dependent upon the concentration of sodium chloride, the vapor pressure of the water would decrease as the concentration of sodium chloride increased. This is due to the fact that as the solute concentration increases, less of the surface area of the frozen sample is occupied by water. In general, most solutions or biological samples will have a eutectic temperature of -10°C to -25°C. However, if the sample contains a simple sugar such as glucose or if the sample is animal or plant tissue, the eutectic temperature may be as low as -30°C to -50°C.

1.4 Freeze Dry Capacity

The volume of a sample that can be freeze dried at one time is related to factors discussed previously and the size and design of the freeze dry system. With any given instrument, the capacity is based on the surface area of the sample; the eutectic temperature and concentration of the sample; and the rate and amount of heat transferred to the frozen sample. Of these factors, the eutectic temperature is the most important factor in determining the amount of sample that can be freeze dried at one time, particularly when flasks are used. This is because as the eutectic temperature decreases, the vapor pressure decreases but the rate of heat absorption by the sample does not change. This tends to promote melting of the sample, which leads to a marked increase in vapor pressure and ultimately overloads the cold trap and vacuum pump. Samples that have eutectic temperatures of -20°C or lower should be placed on the freeze dry system one flask at a time so that the vacuum in the system may recover before adding another sample to the system. If the vacuum does not recover, the capacity of the freeze dry system has been exceeded and the sample should be removed.

If there is a problem with a particular type of sample melting when placed on the freeze dry system, dilution of the sample with more water or providing some insulation around the flask to decrease the rate of heat absorption by the sample may help. If the eutectic temperature of the sample is -40°C to -60°C, the freeze dry system selected for use must be equipped with a cold trap can be cooled to below -75°C, or a dry ice / solvent trap may be used between the cold trap and the vacuum pump.

1.5 Samples Containing Volatile Substances

In certain cases the solvent in a sample to be freeze dried may contain volatile components such as acetonitrile, methanol, acetic acid, formic acid or pyridine. In addition to these substances having an effect on the eutectic temperature, they may increase the vapor pressure at the surface of the sample. Also, compared to water, they will require the absorption of less heat for sublimation to occur. Hence, samples that contain volatile substances will have a greater tendency to melt, particularly when placed in flasks or exposed to room temperature. If a sample containing a volatile substance tends to melt when placed on a freeze dry system, dilution of the sample with more water will help keep the sample frozen. For example, a 0.2 M solution of acetic acid is much easier to freeze dry than a 0.5 M solution.

Chapter 2 Safety Instruction

This user manual is designed to help you learn how to install, use, and maintain your Freeze Dryer.
To reduce the risk of bodily injury, electric shock, fire, and damage to your instrument, please read and observe the precautions in this User's Guide.

Important Information!

- **If the instrument is used in a manner not in accordance with the equipment design, operating instructions or manufacturer's recommendations, the operation of instrument may be impaired to the extent that a safety hazard is created.**
- **Do not attempt to perform electrical work if you are not fully qualified. This manual is not a substitute for electrical training.**

2.1 Disconnect the mains plug!

As current-carrying parts are accessible inside the unit the mains plug must be disconnected before the side panels or the rear panel are opened or before the control panel is removed.
For maintenance work the unit must be switched off with the mains switch.

2.2 CAUTION! Solvents!

Acidic products or products with a high solvent concentration cannot be dried without special protective measures and devices such as, for example, cold trap for protection of the vacuum pump (if necessary check with our factory). The unit can also be damaged by corrosion. Or when solvent contains a little acidic or alkaline substance, users need to choose FD8-series with a cold trap temperature of -86℃ added with A-assembly component to protect your freeze dryer. Special caution is necessary when using azides because a dangerous explosive develops in combination with copper or non-ferrous metals! It is absolutely essential to consult our factory!

2.3 ADVICE! Cleaning and Maintenance of the Unit!

For infectious, toxic, pathogenic and radioactive substances, the danger information of the associated safety regulations must be observed.

2.4 WARNING! Freezing of limbs to surfaces!

During a freeze drying cycle, dangerous situations in the cold trap chamber may arise. When putting sample on the shelves, make sure that no contact with the surface of chamber to avoid frozen injury. In case of your hands or other parts of body touch the frozen surface which could not be detached from the surface, try by applying heat. Liquid should not be used.

2.5 Forbidden freeze drying process

1) Operation of freeze dryer when it is not properly installed.
2) Operation of freeze dryer with panels removed.
3) Operation of freeze dryer by non-authorized personnel.
4) Operation of freeze dryer when the shelves are not properly installed.
5) Operation of freeze dryer with very corrosive substances.
   It is not allowed to dry samples containing high corrosive substances, at least special safety measures have to be observed. The corrosive substances may cause damage to material and or degrade the mechanical strength of the cold trap chamber, drying chamber, lid or accessory components.
6) Operation of freeze dryer with accessories not allowed by the manufacturer, except for commercial freeze drying vessels made of glass or plastic. The user is explicitly warned against using equipment of low quality. Breaking glass or bursting vessels can cause dangerous situations during freeze drying.
7) Operation of freeze dryer in hazardous locations.
8) Do not push or move the freeze dryer during operation. Do not lean on the freeze dryer.
9) Do not place potentially dangerous material, e.g. glass vessels containing liquids, near the freeze dryer.
10) Products which could release high energy during the freeze drying process must not be dried.
11) Do not freeze dry explosive or high flammable substances.
12) Infectious, toxic, pathogenic and radioactive substances may only be dried in suitable vessels. Substances which could cause damage of the shelves and of the chamber must not be dried or only dried if special safety measures have been taken.

2.6 Important Notes

1) This unit must be connected to a wall outlet having protective earth terminal. Connecting to ground terminal constitutes an obligatory protection (220VAC 50HZ).
2) Ambient temperature should be between approx. 5～30℃.
3) Waiting at least 3 minutes before you restart the refrigeration system.
4) If both shelf and flask are requested to use, loading the shelf first. Waiting for at least 30 minutes, you can connect the flask to valve only in case of temperature inside chamber reaching to -50℃ and pressure fall to 30 mTorr.
5) Pre-freeze your samples in a deep freezer at a temperature lower than -30℃ and a time not less than 48 hours.
   Very important: the sample must be deeply and solid frozen.
   In case of your sample containing organic substances or acid, or with high concentration, you need to pre-freeze it in a deep freezer with a temperature of -80℃, and the freezing time should not be less than 24 hours. We suggest a freezing time of 48 hours.
6) Handle the acrylic glass chamber with care. When moving or changing the chamber, put it on a soft surface (i.e. soft cloth or rubber) to avoid damage of chamber.
7) The temperature of cold trap vary widely in a rang of -40℃～-55℃ (FD 5 series), -80℃～-85℃ (FD 8 series) and vacuum degree in a range of 5～100 mTorr, depending on factors of quantity of sample, solvent, concentration, and room temperature, etc.
8) When inserting sterilized air and nitrogen gas with backfilling system, the reading of vacuum gauge should be less than a value of 0.7 Kg. please check and adjust when necessary.
9) The refrigeration compressor is air-cooled. Sufficient air circulation must be ensured. A distance of at least 30cm to the wall should be kept.

10) To prevent fire or shock hazard, do no expose the unit to rain or moisture.
11) The unit should not be positioned near radiators or heat sources. Direct sunshine must be avoided.
12) Remember to lock the caster after your freeze dryer is positioned horizontally (only for Floor type).
13) Check the oil level and quality of vacuum pump oil before putting your freeze dryer into use.
14) Close all vacuum valves, adapters, and drainpipe before starting vacuum pump.

    The condensate and the defrosting water are discharged through the drainpipe at the lower left side of the unit. Pull the drainpipe out and open the drainpipe nozzle to let water out. The condensate and the defrosting water are collected in a vessel.
15) Clean the compressor and the cold trap chamber over a certain period.
16) Shut off the instrument after freeze drying cycle is finished.
17) The oil of the vacuum pump should be changed over a certain period to make sure the pump works in good condition.
18) Do not load too much samples in one time.
19) The room humidity and temperature should not be out of manufacturer suggested range. Humidity of environment is not allowed to exceed 85%.

NOTE!

In order to ensure a vacuum-tight connection and to simplify the removal of the accessories, the ground-in surfaces must be slightly greased with vacuum grease before use. The accessory is then attached and turned by 360° for an even distribution of grease.

Strong-acid or highly-concentrated substances do not allow to be frozen without professionally protective measures and facilities

Chapter 3 Shipments

3.1 Choose a correct installation location

Before Using the System for the First Time:-

1. Please read this User's Guide carefully.
2. Choose a proper installation site which:-
   - The ambient temperature should be between approx. +5°C and +30°C.
   - The refrigeration compressor of the freeze dryer is air-cooled. Sufficient air circulation must be ensured. A distance of at least 30cm to the wall should be kept.
   - The unit should not be positioned near radiators or heat sources. Direct sunlight must be avoided.

NOTE!
In case of insufficient air circulation or too high ambient temperature, the temperature and the pressure in refrigerating system will increase. If the maximum

ATTENTION!
In order to ensure the air circulation of the heat exchanger, do not place any paper, cloths or similar items behind the unit.

3.2 Unpack your freeze dryer

The site for your freeze dryer is properly prepared, you are ready to unpack, inspect, install and test your freeze dryer. To unpack your freeze dryer, take the following steps.

a) Carefully unpack your freeze dryer, accessories and supplies and inspect them for shipping damage. Use the enclosed packing list to verify that all items have been received.
b) If any item listed on your purchase order appears to be missing from your shipment, please search carefully through and under all packing materials. If the item is not found, notify your receiving department immediately. MRC can only be responsible for items reported missing within 10 days of a shipment's arrival.
c) If you receive any damaged items, save the cartons and packing material those items came in for inspection by the insurer. The carrier, dealer, and MRC must be notified within 24 hours in order for your warranty and insurance to apply. Have the transportation company inspect items, fill out a "Report of Damage," and file your claim. Then, notify MRC immediately for repair or replacement.

   IF YOUR FREEZE DRYER WAS DAMAGED IN TRANSIT, YOU MUST FILE A CLAIM DIRECTLY WITH YOUR FREIGHT CARRIER OR INSURANCE COMPANY. MRC AND ITS DEALERS ARE NOT RESPONSIBLE FOR SHIPPING DAMAGE.

   INSURANCE COMPANY MAY REQUIRE THAT CLAIMS BE FILED WITHIN A CERTAIN PERIOD OF TIME. PLEASE CONSULT YOUR INSURANCE COMPANY AND MAKE SURE NOT EXCEEDING THE TIME LIMIT.

3.3 Transport Instructions!

1) Save your shipping boxes and packaging material in case future transport of the instrument becomes necessary.
2) The freeze dryer should be carried by two or more person (Floor type) by holding it underneath on both sides.

WARNING! When transporting or putting down the unit, do not hold the plastic parts. Please note: when putting the unit down on a surface there is a danger of squeezing hands or fingers.

3.4 Packing List

For FD 5 series Freeze Dryer

For common purpose freeze dryer with cold trap temperature of -58℃, you may choose vacuum pump model VP62 or VP162. Hereinafter is a complete list including all necessary accessories for operation of your freeze dryer. However, there is a possibility of the following list being different with what you ordered from us. Please check your delivery items against your purchase order.

Part No.	Name	Description	Qty
FD5-3B, FD5-4B, …FD5-25B	Main Unit	**Freeze dryer FD5 series with B controller**	**1**
VP62	Vacuum Pump	**Vacuum pump** with suction capacity of 62L/min, Ultimate pressure 2×10-4Torr, suitable for freeze dryer of FD5-3,FD5-4, FD5-5, FD5-6series	**1**
VP162		**Vacuum pump** with suction capacity of 165L/min, Ultimate pressure 2×10-4Torr, suitable for freeze dryer of FD5-8,FD5-10, FD5-12….and FD8- series	
VH25	Vacuum Hose	**Vacuum hose** including standard flange connections diameter 25mm for external connection of the vacuum pump VP62 and VP162 **Note: vacuum hose is already attached together with main unit.**	**1**
CDC18*06*12	Drying Chamber	**Clear drying chamber with valves, suitable for B and T controller** 1. Acrylic drying chamber, the cover diameter 260mm, with anti-detonating coating 2. 6 shelves diameter 230mm 3. 12 connections for individually controllable rubber valves for connecting 12 flasks	**1**
S18	Sample Tray	Stainless steel **sample tray** diameter 180mm	4
CF050F	Flask	Flask, 50ml capacity	3
CF100F	Flask	Flask, 100ml capacity	3
CF250F	Flask	Flask, 250ml capacity	3
CF500F	Flask	Flask, 500ml capacity	3
AD29	Flask adapter	**Flask adapter** inner diameter 18.6mm, outer diameter 29mm	**12**
OF	Oil-mist filter	**Oil-mist filter**	**1**
VO	Vacuum oil	1 liter **vacuum oil**	1
VG	Vacuum grease	**Vacuum grease**	**1**

VERY IMPORTANT
ABOVE PACKING LIST IS A COMPLETE ONE INCLUDING ALL NECESSARY ACCESSORIES. PLEASE CHECK THE DELIVERY ITEMS AGAINST YOUR PURCHASE ORDER.

For FD 8 series Freeze Dryer

If your sample containing small amount organic solvent, high concentration, or with high eutectic temperature, you need to choose FD8 series freeze dryer with cold trap temperature of -80℃. The vacuum pump works together with FD8 series freeze dryer should be VP 162 series.

Part No.	Name	Description	Qty
FD8-3B,FD8-4B, …FD5-25B	**Main Unit**	**Freeze dryer FD8 series with B controller**	**1**
VP162	**Vacuum Pump**	**Vacuum pump** with suction capacity of 165L/min, Ultimate pressure 2×10-4Torr, suitable for freeze dryer of FD5-8,FD5-10, FD5-12….and FD8- series	**1**
A-assembly	A-assembly component	A-assembly. -58℃ condenser is not enough to effectively trap organic or acids vapor. Organic or acids vapor condenses when touching a cold surface, which cause vacuum hose, sealing and valves eroded. You should make correct choice by adding your FD series Freeze Dryers an A-assembly and choose a freeze dryer with a -86℃ condenser. A-assembly including the following components and features specially designed for handling organic solvents or acids sample:- 1) -86℃ Cold Trap made of AISI316 stainless steel, which is able to endure acid and alkali. 2) Upgrading vacuum hose, valves to corrosion-resistant ones so as to keep a perfect sealing effect. 3) Adding acid and alkali resistant filter at the inlet of vacuum system.	**1**
VH25	**Vacuum Hose**	**Vacuum hose** including standard flange connections diameter 25mm for external connection of the vacuum pump VP62 and VP162 **Note: vacuum hose is already attached together with main unit.**	**1**
CDC18*06*12	**Drying Chamber**	**Clear drying chamber with valves, suitable for B and T controller** 1. Acrylic drying chamber, the cover diameter 260mm, with anti-detonating coating 2. 6 shelves diameter 230mm 3. 12 connections for individually controllable rubber valves for connecting 12 flasks	**1**
S18	Sample Tray	Stainless steel **sample tray** diameter 180mm	4
CF050F	Flask	Flask, 50ml capacity	3
CF100F	Flask	Flask, 100ml capacity	3
CF250F	Flask	Flask, 250ml capacity	3
CF500F	Flask	Flask, 500ml capacity	3
AD29	Flask adapter	**Flask adapter** inner diameter 18.6mm, outer diameter 29mm	**12**
OF	Oil-mist filter	**Oil-mist filter**	**1**
VO	Vacuum oil	1 liter **vacuum oil**	1
VG	Vacuum grease	**Vacuum grease**	**1**

VERY IMPORTANT
ABOVE PACKING LIST IS A COMPLETE ONE INCLUDING ALL NECESSARY ACCESSORIES. PLEASE CHECK THE DELIVERY ITEMS AGAINST YOUR PURCHASE ORDER.

Chapter 4 Getting Started

After you verify receipt of proper components and move your freeze dryer to a location you want to install it, following the steps listed below:

4.1 Checking Voltage setting

Power Supply

The operating voltage on the name plate must correspond to the local supply voltage.

MRC laboratory freeze dryers are units of safety class I which is equipped with a three- wire 230 VAC safety plug with ground contact.
Please use a separate socket power.

Checking the ground connection

Voltage:

Working conditions of this unit are 230VAC 50Hz

Please confirm the unit must be plugged into a grounded socket before put it into use.

WARNING

- **This unit must be connected to a wall outlet having protective earth terminal. Connecting to ground constitutes an obligatory protection.**
- **To prevent fire or shock hazard, do no expose the unit to rain or moisture.**
- **Unplug the unit from the wall outlet if you will not use it for a long time. Disconnect the power cord by grasping the plug. Never pull the cord itself.**

4.2 Installation of Key Touch Screen

1. The controller (key touch screen) is shipped in a separate carton. Open the package carefully; take out the key touch screen.
2. Cables connection
   2.1 Key Touch screen should be connected with three cables of freeze dryer, see Fig. 4.1:

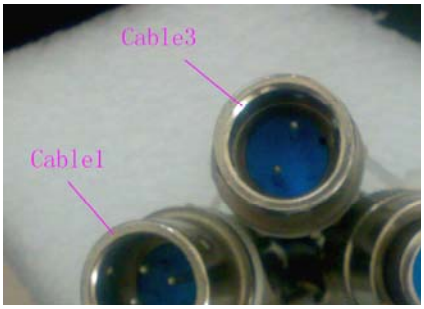


Fig. 4.1 Cables connection

2.2 According to following instruction, connect the following three ports of key touch screen with correct cables shown above. See Fig. 4.2 :

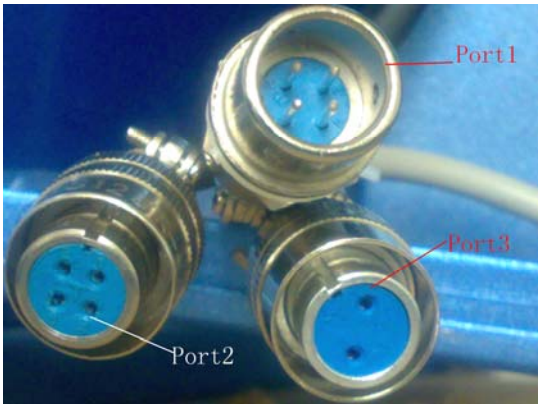


Fig. 4.2 connect cables with ports of key touch screen

Connect cable 1 to port 2
Connect cable 2 to port 1
Connect cable 3 to port 3

The key touch screen is connected correctly and ready to use.

4.3 Vacuum Pump Connection

A vacuum pump is required to operate your freeze dryer properly. The freeze dryer is equipped with a heavy wall vacuum hose for connecting the cold trap to the vacuum pump.

If your freeze dryer is a bench top one, you should connect the vacuum pump power cord to the receptacle on the back of the unit. There is an on/off switch on the vacuum pump. If you turn the switch on, the vacuum pump will be controlled by the freeze dryer. Connect the vacuum pump inlet port to the vacuum tube located on the back of the unit with the vacuum hose and clamps provided. If necessary, cut the hose to proper length to allow for gentle bends without kinks.
If your freeze dryer is floor type model, the vacuum pump is connected well in factory.

Make sure that the oil level of vacuum pump is at a proper position (between max. and min.)

When you get a bench-top Freeze Dryer, you need to connect vacuum pump as following instruction:

1. Get accessories and vacuum pump out of the package carefully.

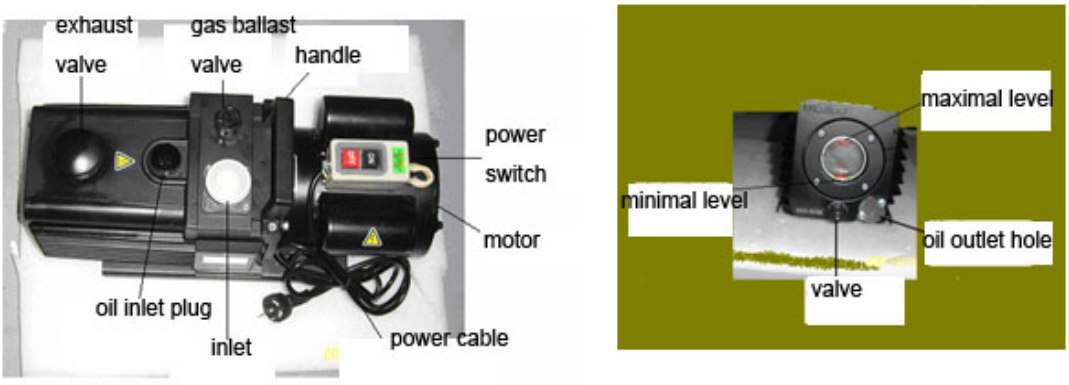


Fig.4.3 Vacuum pump before connection. Index of the pump parts

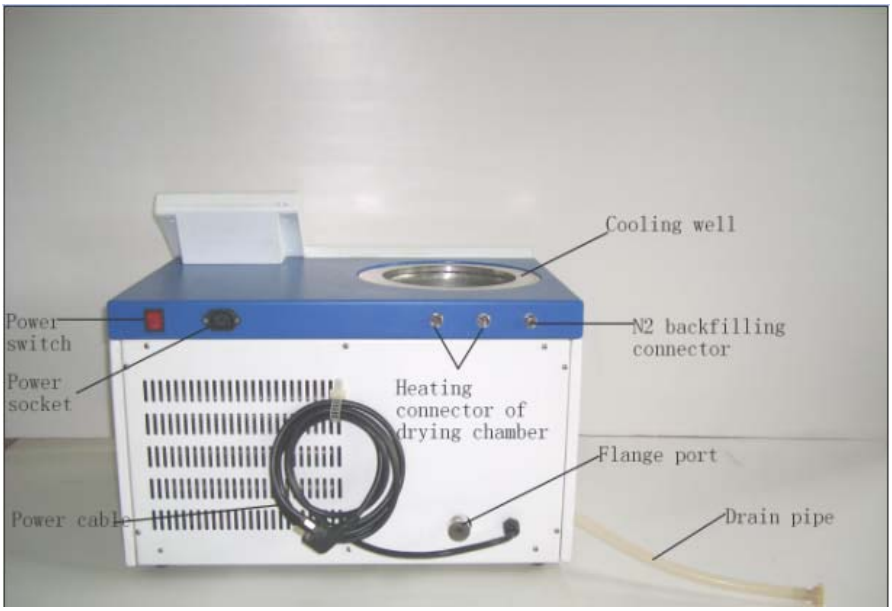


Fig.4.4 Back view of freeze dryer

Accessories (delivered with vacuum pump) required:
We need KF16 Flange, KF16 O-ring Coil, KF16 clamp, KF25 Flange, KF25 O-ring Coil and KF25 clamp to connect Vacuum Pump to Freeze Dryer. See Fig 4.5:

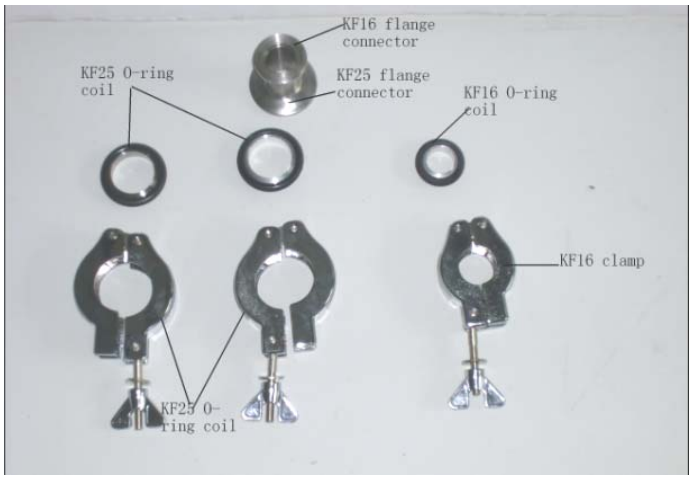


Fig. 4.5 Vacuum pump Accessories

2. How to connect Vacuum Pump to Freeze Dryer:
   1) Connecting accessories to vacuum hose.

Fig.4.6 vacuum hose and accessories

2) As per instruction shown in Fig. 4.7, connecting vacuum hose with vacuum hose flange connector.

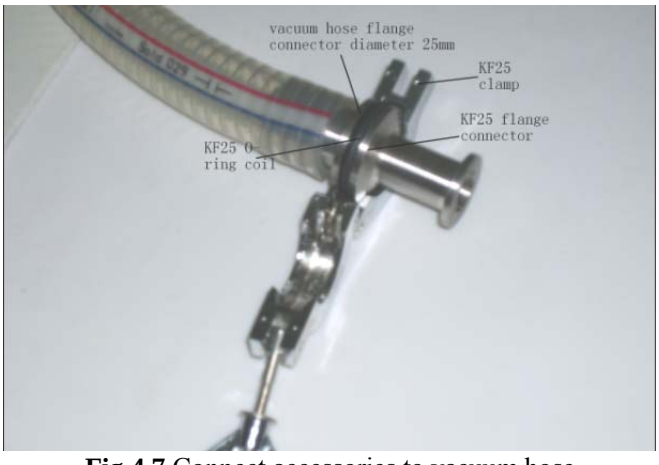


Fig.4.7 Connect accessories to vacuum hose

3) Connecting vacuum hose (already installed vacuum hose flange) to Freeze Dryer.

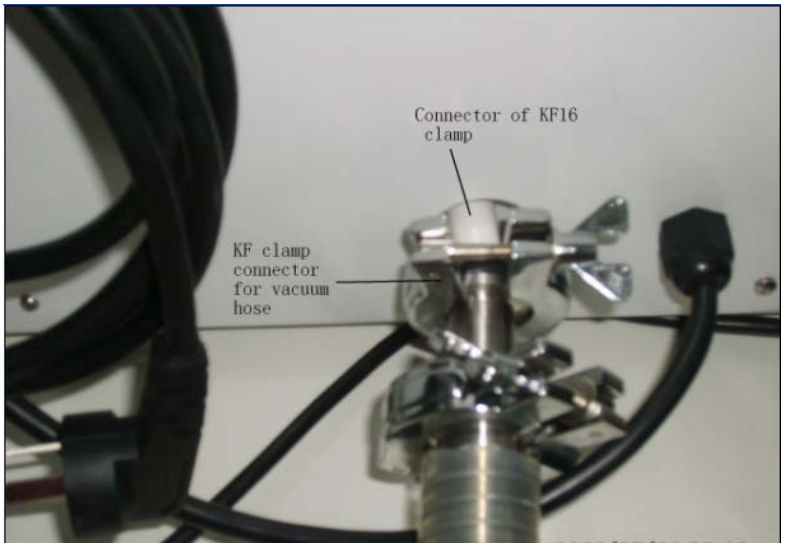


Fig.4.8 Connect Flange port in Freeze Dryer to KF16 Flange

Connect the KF16 flange connector (see Fig. 4.5) to the 16mm flange port (see Fig. 4.4) of freeze dryer. The connection method of 16mm flange (Fig.4.4) and KF16 flange connector (Fig. 4.5) is as the same as that shown in Fig. 4.7.

4) Connecting vacuum hose to Vacuum Pump:

Fig.4.9 Connect Flange port in Vacuum Pump to KF25 Flange

Connect one end of vacuum hose to KF25 flange (as per instruction shown in Fig. 4.7);
Connect the other end of vacuum hose to KF25 inlet flange port of vacuum pump as per Fig. 4.9, then fasten it using a KF25 clamp.

5) Connecting Oil-mist Filter to Vacuum Pump

Fig.4.10 Connect oil-mist filter

The connecting method of vacuum pump and oil-mist filter is as the same as instruction shown in Fig. 4.10.

Note: Connect the black port of oil-mist filter to Vacuum Pump. The arrow on oil-mist filter is downward (as shown in Fig. 4.10).

Fig. 4.11 After installation

6) Connecting power cord of Vacuum Pump to the socket of Freeze Dryer.

Fig. 4.12 After installation of vacuum pump

Now we finish the connection of vacuum pump with freeze dryer.

4.4 Connection of clear drying chamber

4.4.1 Open the package and take out drying chamber carefully.

4.4.2 Put clear drying chamber onto the chamber holder located on the upside of freeze dryer.

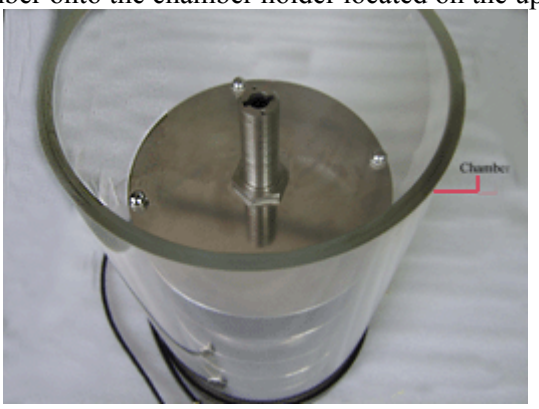


Fig. 4.13 install clear drying chamber frame

4.4.3 Connecting the lid (see fig. 4.14) to the drying chamber (see fig. 4.13)

Fig. 4.14 connecting lid of chamber

4.4.4 Drying Chamber with lid and stoppering system (see fig.4.15)

Fig. 4.15 drying chamber with lid

4.4.5 Connecting valves to the lid. You will find valves (left) and adapters (right), see fig. 4.16:

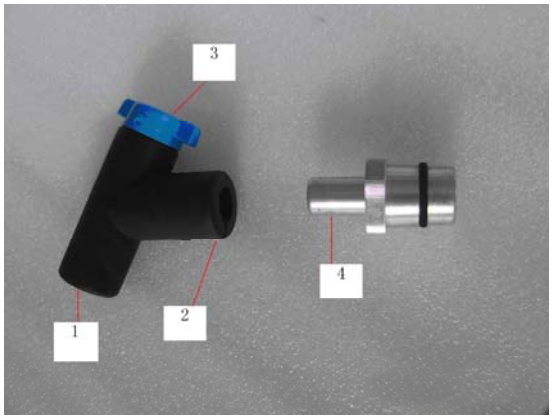


Fig. 4.16 connecting adapters and valves

4.4.6 Connecting port 1 of the valves with the connector of the lid.

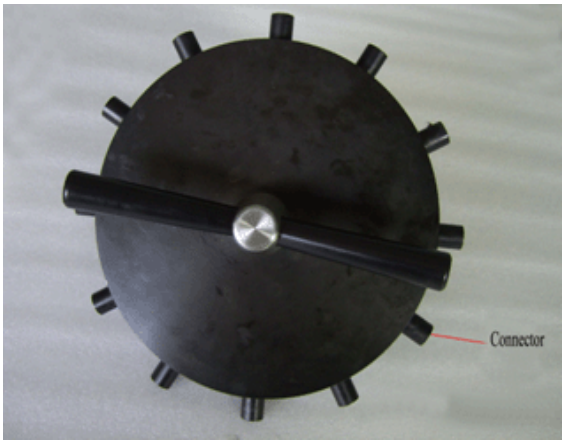


Fig.4.17

Remember to coat the vacuum grease on the connector and inside surface of the valves

4.4.7 Connecting the port 2 of the valve to the port 4 of the adapter (see fig.4.16)
4.4.8 Connecting the flask to the another side of the adapter (see fig. 4.18)

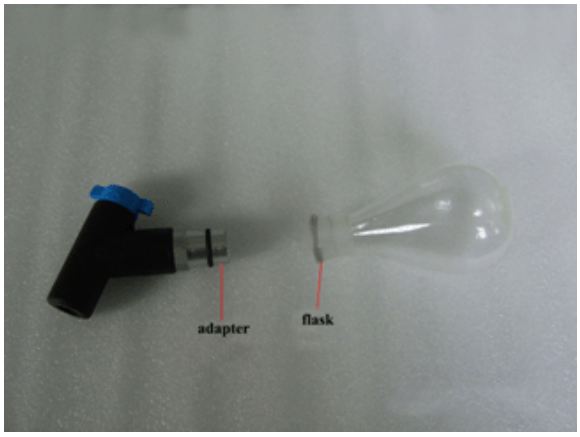


Fig. 4.18 connecting flask

Now we finish the connection of drying chamber.

Appendix: Chemical resistance of freeze dryer components

The freeze dryer is designed to be chemically resistant to most compounds that are commonly used in freeze drying processes. However, by necessity, the freeze dryer is comprised of a number of different materials, some of which may be attacked and degraded by certain chemicals. The degree of degradation is dependent on the concentration and exposure duration. Some of the major components of FD 5 series that are susceptible to degradation are as follows:

		Acids			**Buffers**		**Solvents**						
Component	Material	Acetic	Formic Acid	Trifluoroacetic Acid(TFA)	Calcium Chloride	Sodium Phosphate	Acetone	Acetonitirle	Carbon Tetrochloride	Cyclohexane	Dioxane	Methyl t-Butyl Ether (BTBE)	Pyridine
Valve Stem	Acetal	C	D	D	D		D						
Chamber *	Acrylic						D	D	D				
Hoses Gasket & Valve Bodies	Neoprene						C	C	D	D	D	C	D
Flask Top	Silicon Ruber		C	D		D			D	D	D	C	D
Chamber Adapters	Stainless Steel				C								

* Drying chamber with PTFE interior is available on request.
C- Moderate degradation; Limited use.
D- Severe degradation; infrequent use recommended; immediate thorough cleaning required.

Most common compounds used in freeze drying processes, if allowed to enter the vacuum pump, will degrade the oil and cause damage to the vacuum pump.
Sugars and proteins typically will have minimal negative effect on any of the materials of construction.

When using compounds in the freeze dryer that are hostile to the materials of construction, it is imperative the equipment is thoroughly cleaned after use.

Rubber and plastic components that have been exposed to damaging compounds should be removed and flushed with water.

The oil in the vacuum pump should be checked often. It must be changed if it is cloudy, shows particles or is discolored. The useful life of vacuum pump oil can be extended if the vacuum pump is operated for an extended period of time after a freeze dry run. This allows contaminants to be purged from the hot oil. This must be done with the inlet to the pump blocked off to prevent air from free flowing through the pump. This is accomplished by closing all sample valves on a clean, dry freeze drying system and turning on the vacuum pump.

With prudent maintenance the freeze dryer will provide years of service. Warranty on the affected parts will be voided if maintenance has been obviously neglected. If you have question about using specific compounds in the freeze dryer, contact MRC technical service or your local distributor.

Solvent safety precautions

Solvents used in the freeze dryer may be flammable or hazardous to your health. Use extreme caution and keep sources of ignition away from the solvents. When using flammable or hazardous solvents, the vacuum pump must be vented to or operated inside a fume hood.

Hazardous materials such as strong acids or bases, radioactive substances and volatile organics must be handled carefully and promptly cleaned up if spilled. If a sample is spilled in the drying chamber it must immediately be cleaned up.

WARNING:
The disposal of substances used in connection with this equipment may be governed by various government or local regulations. All users of this equipment are urged to become familiar with any regulations that apply in the user's area concerning the dumping of waste materials in or upon water, land or air and to comply with such regulations.

Chapter 5 Operation

5.1 Operation Checklist

The following checklist should be followed prior to each use of your freeze dryer:

1. Wipe the interior of the cold trap chamber with a soft cloth or paper towel to remove any accumulated moisture.
2. Check the cold trap chamber drain hose to ensure that the hose is free of moisture and that the drain plug is securely installed.
3. Using a soft, lint-free cloth or paper towel, wipe the drying chamber lid gasket to remove any dirt and contaminants that could cause a vacuum leak. Vacuum grease is not required on the lid gasket to obtain a proper vacuum level.
4. Check the level and color of vacuum pump oil. The oil level should be located between max. and min. limit. When necessary, change or add new vacuum oil.
5. Electrical Connection. Plug the power cord into the receptacle on the back of the freeze dryer and the other end into a suitable power receptacle.
   The power switch located on the rear of the panel, switch it "ON", now the unit is ready.
   You may begin a freeze drying cycle directly. Freeze dryer with B controller could digital display working condition (cold trap temperature, vacuum degree) in real time.

NOTE

- **Please put it on 'OFF" position when the machine is not in use.**
- **Do not use the freeze dryer in a manner not specified by the manufacturer. The electrical protection properties of the freeze dryer may be impaired if the freeze dryer is used inappropriately.**

5.2 Preparation: pre-freezing samples

1. Appropriate containers for freeze drying include ampoules, serum bottles, and freeze drying flasks. The sample container size should always be at least two to three times the sample size (i.e., 40 ml samples should be prepared in 80ml containers or larger).

   NOTE: The sample must be deeply frozen to solid state.
   Pre-freeze the samples in a deep freezer. The temperature required for pre-freezing is dependent on the characteristics of the sample. Pre-freezing temperature typically is at least 10 to 20℃ below the eutectic or collapse temperature of the sample. To be safe, please ensure the sample be frozen in a deep freezer at the temperature of -30□ for a period of not less than 48 hours. The experiment material is better to be centrifuged by a centrifugal concentrator before refrigeration and then pre-refrigerate it if the material is turbid liquid, accelerating freeze-drying speed.

2. Liquids are frozen in flasks according to the freezing principle, by hand or better with a rotator. These freezing methods reduce the layer thickness so as to shorten drying time to a considerable extent.

5.3 Preparation: connecting accessories

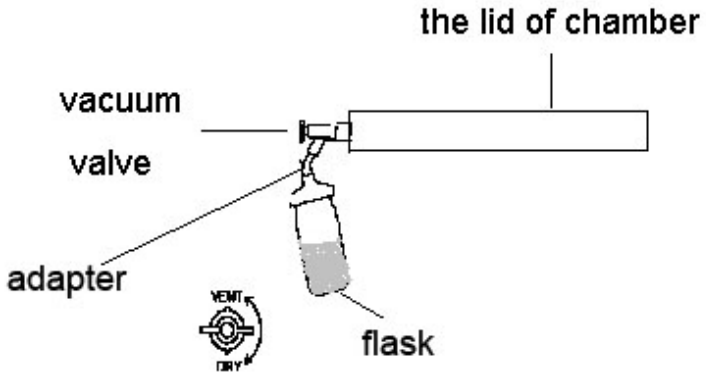


Fig. 5.1 Illustration of connecting accessories

1. How to connect flasks?

Put the test material on the flask bottom and freeze it covered with plastic wrap in deep freezer under temperature of -30℃, the freezing time is not less than 48 hours.

* Detailed connecting information refers to "4.4 Installation of clear drying chamber".

2. How to dry samples in the serum bottle?

Place serum bottles on the shelves inside the drying chamber, leaving 3-5mm gap between lid and body. After a drying cycle is completed, press the lid onto the serum bottle by stoppering system, then using a capping device to seal these bottles with aluminum coat.

3. How to dry samples in ampoules?

- Put the sample into ampoule bottles and connect the bottle opening to the adaptors of freeze dryer chamber.
- Turn the VENT valves indicated at the top of the stem by 180°;
- The sample starts to be dried.

4. How to dry loose unpacked material in sample tray?

- Pre-freeze samples in freezer for not less than 48 hours.
- Remove the Acrylic glass body of drying chamber, place frozen samples on the tray.
- Replace the acrylic glass body of drying chamber.
- Cover the chamber lid and start a freeze drying process.

5.4 Loading sample

1. Connect the freezer dryer to the mains power, the power request 220-230V, 50Hz, this unit must be connected to a wall outlet having protective earth terminal.
2. Wait until the cold trap temperature down to -50℃ and vacuum degree down to a value less 50 mTorr.
3. Load sample into drying chamber, close the valves.
   - When drying sample in flasks, connect a pre-frozen sample to a sample valve on the drying chamber using an adapter.
   - Before adding another sample, allow system vacuum to return to 50 mTorr or lower. Any combination of valves and sample sizes may be utilized at one time provide that the system vacuum and cold trap temperature remain sufficiently low to prevent melting of the frozen sample.

TIPS

- The ground-in surfaces have to be cleaned and greased before any further installation of accessories.
  Note: Don't coat too much grease on surfaces of accessories, too much grease also could cause vacuum leakage.
- In order to ensure a vacuum-tight connection and to simplify the removal of accessories, the ground-in surfaces must be slightly greased with vacuum grease. After all accessories attached, manually turned by 360° for an even distribution of grease.
- Before running a drying process, it is necessary to check that all valves are closed. You need to start drying process in the control panel, then the pressure control valve opens and the main drying phase starts.
- Most of the available valves allow repeatedly flasks connection and removal during the drying process. If you find the valves are stiff and hard to handle, you must dismantled, cleaned the valves, slightly greased with vacuum grease and then reassembled.

5.5 Operating the Freeze Dryer

5.5.1 Start-up

Your freeze dryer may be configured to automatically start the vacuum pump when the cold trap temperature reaches -58℃. The display unit for vacuum may be mBar, and the temperature may be displayed as . The working condition of the refrigeration system and the vacuum pump may be monitored.

5.5.2 Operating procedure in Manual mode

To run your freeze dryer in manual mode, following the steps listed here:

1. Sample is frozen in a deep freezer at the temperature of -30^{O}C for a period of not less than 48 hours.
2. Press the mains switch to power the unit on. You may find the following button on the panel:

REF	**Refrigeration System**
PUMP	**Vacuum pump**
PURGE	**Backfilling system**
DEF	**Defrosting system**
HEATER	**Heated drying system**

3. Run a performance check.
   a) **Performance check of refrigeration system**. Start cooling system (compressor) by click on the button "REF", your freeze dryer will begin cooling after 3 minutes automatic delay protection. You will find the displayed temperature started to decline.
   Check: The displayed temperature (cold trap temp.) should reach -50 ^{O}C (FD 5 series) or -80 ^{O}C (FD 8 series).
   b) **Performance check of vacuum pump**. After refrigeration system performance check is finished, press "PUMP" button to start vacuum pump. You will find the displayed vacuum degree is declining.
   Check: the vacuum degree should less than 50 mTorr.
4. Load sample. Let refrigeration system work continuously, press the "OFF" button of vacuum pump to release vacuum, then you can load sample.
   a) **For flask application**. If you using flasks as drying container, you may connect maximum 12 flasks with frozen sample inside to adapters when displayed temperature reaches -50℃or -80 ℃and the pressure reaches 30mTorr. Then slowly open the vacuum valves.
   Note:
   - **If you drying sample in flasks, the vacuum pump should keep working when attaching flasks to drying chamber.**
   - **Before adding another flask, allow system vacuum to return to 50 mTorr or lower.**
   b) **For serum bottles application**. You can put sample in serum bottles directly on the shelves.
   c) **For ampoule bottles application**. Connect the bottle opening to the ampoule adaptors of freeze dryer chamber. Turn the VENT valves indicated at the top of the stem by 180°;
5. Pressing "PUMP" button to start vacuum system again when you have finished sample loading.
6. The main freeze drying phase is beginning. At this phase, both refrigeration system and vacuum pump are in working condition.
7. When all the frost has disappeared from the outer surface of the sample container and no cold spots can be detected by handling the container, the sample is nearly dry. To be certain of low final moisture content, dry the sample for several hours past this point.
8. After a drying cycle is complete, stop the vacuum system firstly by pressing the "PUMP" to OFF, then the vacuum backfilling system automatically switches on and the "PURGE" indicator flashes.
9. Sealing the bottles and remove the dried sample.

Important Information

- *If you use serum bottle as drying container and you have chosen drying chamber with sealing function. Serum bottle can be sealed with serrated rubber stoppers inside the drying chamber under vacuum or inert gas. To do this, the shelves are moved against each other by a pressure plate using a spindle. After completion of a drying process, the lever of the rotary leadthrough is turned to the right until a resistance is felt.*
- *If you use ampoule bottle as drying container, you need to choose drying chamber suitable for ampoules application. Ampoules may be flame sealed by a sealing torch.*

NOTE
When sealing ampoule bottles, care must be taken not to burn the adapter.
An insulation material placed between the adapter and the torch is recommended.

10. Defrost the cold trap if necessary.
    At the end of a run or when a sufficient amount of condensate accumulates in cold trap to obstruct the flow of vapor to the cold trap chamber, your freeze dryer should be defrosted. The following procedure should be followed when defrosting:

    a) Firstly, start on the Defrosting system by pressing the "ON " button of "DEF" menu;
    b) The ice covered on cold trap will be defrosted by the Hot Gas system, lay down the drainpipe to dispose the liquid appropriately.
    c) Flush the cold trap chamber with water and wipe chamber dry.
    d) Reinstall the drain hose plug and slide drain hose back into the side of the cabinet. Dispose of the liquid appropriately.

NOTE
Utilization of acid requires immediately cleaning and neutralization after defrost or physical damage to the cold trap chamber will result.

Do not attempt to chip ice from the wall of cold trap by force as damage may occur to the chamber of cold trap.

Never attempt to start the vacuum pump when there is liquid in the cold trap chamber. This could result in damage to the vacuum pump.

11. After all drying process is completed, power off the unit and cut off power supply. Close the vent valve and vacuum valve.

NOTE
2ml, 5ml, 7ml, 10ml and 15ml serum bottles are suitable for drying chamber with stoppering system.

10ml, 15ml, 20ml and 30ml serum bottles are suitable for drying chamber without stoppering system.

5.5.3 Operating procedure in Automatic mode

To run your freeze dryer in automatic mode, following the steps listed here:

1. Sample is frozen in a deep freezer at the temperature of -30^{O}C for a period of not less than 48 hours.
2. Press the mains switch to power the unit on. You may find the following button on the panel:

REF	**Refrigeration System**
PUMP	**Vacuum pump**
PURGE	**Backfilling system**
DEF	**Defrosting system**
HEATER	**Heated drying system. Heater function is only available for freeze dryer with P controller.**

3. Performance check.
   c) **Performance check of refrigeration system**. Start cooling system (compressor) by click on the button "REF", your freeze dryer will begin cooling after 3 minutes automatic delay protection. You will find the displayed temperature started to decline.
   Check: The displayed temperature (cold trap temp.) should reach -50^{O}C (FD 5 series) or -80 ^{O}C (FD 8 series).
   d) **Performance check of vacuum pump**. After refrigeration system performance check is finished, press "PUMP" button to start vacuum pump. You will find the displayed vacuum degree is declining.
   Check: the vacuum degree should less than 50 mTorr.
4. Load sample. Let refrigeration system work continuously, press the "OFF" button of vacuum pump to release vacuum, then you can load sample.
   d) **For flask application**. If you using flasks as drying container, you may connect maximum 12 flasks to adapters when displayed temperature reaches -50℃or -80℃and the pressure reaches 30mTorr. Then slowly open the vacuum valves.
   Note:
   - **If you drying sample in flasks, the vacuum pump should keep working when attaching flasks to drying chamber.**
   - **Before adding another flask, allow system vacuum to return to 50 mTorr or lower.**
   e) **For serum bottles application**. You can put sample in serum bottles directly on the shelves.
   f) **For ampoule bottles application**. Connect the bottle opening to the ampoule adaptors of freeze dryer chamber. Turn the VENT valves indicated at the top of the stem by 180°;
5. Pressing "PUMP" button to start vacuum system again when you have finished sample loading.
6. The main freeze drying phase is beginning. At this phase, both refrigeration system and vacuum pump are in working condition.
7. Switch the mode from Manual to Auto mode. The Auto mode could lock all buttons to avoid unintentional faulty operation.
8. When all the frost has disappeared from the outer surface of the sample container and no cold spots can be detected by handling the container, the sample is nearly dry. To be certain of low final moisture content, dry the sample for several hours past this point.
9. After a drying cycle is complete, switch the mode from Auto to Manual, then stop the vacuum system firstly by pressing the "PUMP" to OFF, the vacuum backfilling system will automatically switch on and the "PURGE" indicator flashes.
10. Sealing the bottles and remove the dried sample.

Important Information

- *If you use serum bottle as drying container and you have chosen drying chamber with sealing function, serum bottle can be sealed with serrated rubber stoppers inside the drying chamber under vacuum or inert gas. To do this, the shelves are moved against each other by a pressure plate using a spindle. After completion of a drying process, the lever of the rotary leadthrough is turned to the right until a resistance is felt.*
- *If you use ampoule bottle as drying container and you chosen drying chamber special for ampoules application, ampoules may be flame sealed by using a sealing torch.*

NOTE

When sealing ampoule bottles, care must be taken not to burn the adapter.
An insulation material placed between the adapter and the torch is recommended.

11. Defrost the cold trap if necessary.
    At the end of a run or when a sufficient amount of condensate accumulates on the cold trap to obstruct the flow of vapor to the cold trap chamber, your freeze dryer should be defrosted. The following procedure should be followed when defrosting:

    a) Firstly, start on the Defrosting system by pressing the "ON " button of "DEF" menu;
    b) The ice covered on the cold trap will be defrosted by the Hot Gas system, lay down the drainpipe to dispose the liquid appropriately.
    c) Flush the cold trap chamber with water and wipe chamber dry.
    d) Reinstall the drain hose plug and slide drain hose back into the side of the cabinet. Dispose of the liquid appropriately.

NOTE

Utilization of acid requires immediately cleaning and neutralization after defrost or physical damage to the cold trap chamber will result.

Do not attempt to chip ice from the wall of cold trap by force as damage may occur to the chamber of cold trap.

NEVER attempt to start the vacuum pump when there is liquid in the cold trap chamber. This could result in damage to the vacuum pump.

12. After all drying process is completed, power off the unit and cut off power supply. Close the vent valve and vacuum valve.

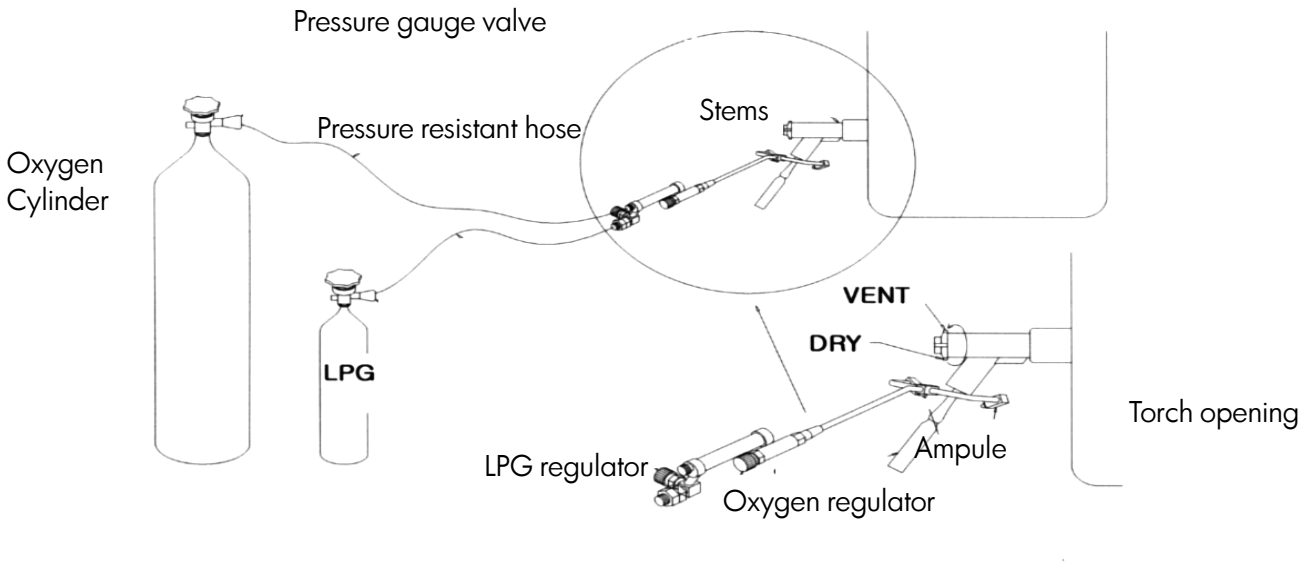
NOTE

2ml, 5ml, 7ml, 10ml and 15ml serum bottles are suitable for drying chamber with stoppering system.

10ml, 15ml, 20ml and 30ml serum bottles are suitable for drying chamber without stoppering system.

5.6 How to use sealing torch

Fig. 5.2 Illustration of sealing torch



1) **Purpose of sealing torch**: After sample in ampoule is dried, you can use sealing torch sealing ampoule bottles to keep dried sample in vacuum condition.
2) **How to connect sealing torch:** Connecting the pressure-resistant hose to the oxygen and LPG cylinder, then connect the other end of hose to a sealing torch.
   🔔 ***Please check whether there is a gas leakage in the connection of LPG cylinder and the sealing torch.***
3) When the sealing torch is connected, slowly counterclockwise turn the LPG regulator to the left a little bit.
4) When you find LPG gas comes out of two torch holes, light the torch quickly by lighter or firelighter.
   Note: Care must to be taken when light the torch to avoid burn.
5) If the torch is lighted, you will find red color flames come out of two torch openings. Adjust the flame and make it become blue color flame by counter-clockwise turning the oxygen regulator to the left slowly.
6) Heating the middle part of the ampoule opening using the blue flame of sealing torch. (see Fig. 5.2)

VERY IMPORTANT:

🔔 ***Please firmly hold the ampoule by one hand to prevent it from dropping.***

🔔 ***When sealing ampoule bottles, care must be taken not to burn the adapter. An insulation material placed between the adapter and the torch is recommended.***

Chapter 6 MAINTANENCE

Under normal operation, your freeze dryer requires little maintenance. The following maintenance schedule is recommended:

6.1 Maintenance of freeze dryer

As needed:

1. Clean up all spills; remove liquids from the chamber.
2. Clean lid and gasket using soft cloth, sponge or chamois and a mild, non-abrasive soap or detergent.
3. Check oil level of the vacuum pump. It should be between MIN and MAX. If the oil level is less than an inch (25.4mm) above MIN, add oil to proper level.
4. If oil shows cloudiness, particles or discoloration, drain the pump and replace with fresh oil.
5. Utilization of acids requires immediate cleaning and neutralization after a run or physical damage to the collector chamber and collector coil will result.
6. Check the cold trap for condensed or frozen solvents and dispose of appropriately. Completely empty the cold trap before the next run or before attempting to start the vacuum pump.
7. If sample valves leak or stems become difficult to turn, pull the stem out of the rubber valve body and apply a thin coat of vacuum grease to the step. Reinsert the stem into the valve body.

Monthly:

1. The rubber components on the freeze dryer may eventually deteriorate and require replacement. The effective life of rubber parts depends upon both their usage and the surrounding environment. Check all rubber hoses and gaskets and replace any that show signs of hardening, permanent set or deterioration.
2. Using a soft cloth, sponge or chamois and a mild, non-abrasive soap or detergent, clean the acrylic chamber lid.
3. Using a soft cloth, sponge, or chamois and a mild, non-abrasive soap or detergent, clean the exterior surfaces of the freeze dryer. Liquid spray cleaners and polishes may be used on the exterior surfaces. Do not use solvents to remove stains from the exterior surfaces as they may damage the finish.

Annually:

Every 12 months, or more often if the freeze dryer is operated in a dusty environment, the refrigeration system condenser should be cleaned. Using a vacuum cleaner with brush attachment clean the condenser to ensure proper airflow for peak performance.

6.2 Maintenance of vacuum pump

Fig. 6.1 Index of the parts

6.2.1 Oil change frequency

1) The oil of the vacuum pump should be changed over a certain period to make sure the pump will rum optimally.
2) Viewing the oil through oil gauge, when the color is not clear or turn to dark yellow, you need to change vacuum oil.
3) If water vapor enters into vacuum oil, the color of oil will turn white and grey. In this case, you need to close all valves in vacuum system, then start vacuum pump and open the gas ballast valve shown in Fig. 6.1. Let vacuum pump run approximate 20 minutes to exhaust vapor inside oil. If the oil color does not change, you need to change new oil.
4) The changing period of oil depends on the sample which is freeze dried, but a general rule of thumb is to change the oil every 700 to 1000 running hours.

6.2.2 How to change vacuum oil

1) Stop vacuum pump. Loosen the vacuum tube connecting the chamber and vacuum pump to disconnect the pump from the vacuum circuit.
2) Put a basin under the oil output. Make the oil exhaust plug open by turning the plug to the left (counter clockwise). After oil is exhausted, close oil exhaust plug, start the pump and let it run about five seconds, then stop the pump again. This is to let oil completely exhausted. Check the oil gauge and confirm the oil is fully exhausted.
3) Check and confirm the oil exhaust plug is closed.
   Notes: the drain plug and pump drain should be fit on the right way.
4) Turn the oil inlet plug of pump to the left (counter clockwise) to open it. Fill in the new oil through the opening. Fill oil up to the maximum line of oil gauge.
5) Turn the oil inlet plug to the right to close it.
   Notes: the drain plug and pump drain should be fit on the right way.
6) Reconnect the vacuum pump and vacuum pipes with your freeze dryer with clamps.

Chapter 7 Trouble Shooting

7.1 . Troubleshooting

Symptom	Remedy
1. The voltage supplied to the freeze dryer varies beyond allowable limits: - The normal voltage range varies from 215 V to 225V. - If the voltage supplied to freeze dryer is not in normal range, the compressor cannot work efficiently or cannot operate.	- Check and change correct power supply. - Use AVR for 220V or Voltage Booster option.
2. The cold trap (ice condenser) could not go down to preset temperature.	- Check if the room temperature is above 28 ℃. When the room temperature is above 30℃, the condenser cannot be cooled at a proper efficiency. Please make sure the ambient temperature is not above 28 to optimize the cooling efficiency of freeze dryer.
3. When the room temperature is under 0℃: The oil in compressor will be condensed. It can have negative effect on the operation of compressor Each electrical part can be wrongly operated.	- Please your freeze dryer in a location with ambient temperature not less than 5℃ above zero.
4. In case there is excessive dust around the unit - This unit uses an air-cooled condenser. In case of excessive dust around the unit, dust will pile up at the front of the condenser. This will cause the compressor to not work effectively. This one of possible causes of a defect compressor.	- Open air-cooled condenser once in a month, remove dust and clean it. - Wipe the dust off the condenser with a soft brush.
5. Operate freeze dryer in a location with heavy humidity: - It can cause a technical malfunction in the electrical applications or short circuit.	- Ventilate the installation location properly by using a ventilator or by opening the windows - Try to use an option to reduce moisture will be helpful.

7.2 Before you asking for technical assistance:

NOTICE
Before you contact MRC or your local distributor for service and repair assistance, please check your freeze dryer against the following information:

1. The unit does not work at all.
- Check the power supply (230V)
- Check the power supply plug connection.
- Check whether you turn on the unit according to user instructions.

2. The freeze dryer does not work properly.
- Do not place heat-emitting appliances around the freeze dryer.
- Check whether the condenser is blocked by dust.
- Check whether too much samples are loaded at one time.
- Check whether the pre-freezing time of samples is long enough.
- Check whether you have turned on the unit according the instructions.

3. No vacuum condition created.
- Check whether the vacuum pump works.
- Check whether the oil change period of the vacuum pump has passed.
- Check whether the drain valve is closed.
- Check whether the vacuum valve is closed.
- Check whether too much samples are loaded at one time.
- Check whether the pre-freezing time of samples is long enough.
- Check whether you turn on the unit according the instructions.

4. Superfluous oil is founded at the bottom of the unit
- During operation of vacuum pump, little oil can flow out of the air outlet of the vacuum pump.

  Remedy: replace the components of the exhaust filter at the upper part of the vacuum pump.

5. Too much running noise
- Check whether the floor is even.
- Check whether the noise comes from the compressor.

  🔔 The noise of the compressor is bigger than that of household refrigerators.
- Check whether the noise comes from the vacuum pump.

  🔔 When the noise is bigger than normal, please check the following:

  A. Whether the vacuum pump is installed on the correct position.

  Remedy: in the case of a wrong position, please change the position of pump a little bit.

  B. Check the vacuum circulation to see if circulation valve or drain valve has been closed.
  Remedy: in the case of any valves open, close them.
  C. Check to see if the gas ballast valve located at the upper part of vacuum pump is open too widely.
  Remedy: If ballast valve is open too widely, adjust it to a correct position (clockwise).

6. Do you hear sound of water stream?

- This is caused by circulation of refrigerant. It is not a technical problem.

7. Do you hear a cracking sound when you turn on the unit?

- This is caused by magnetic relay system. It is not a technical problem.

8. Any unusual smell?

- If you feel abnormal smell while vacuum pump is running, please check your unit against the following:

A. It can be caused by the residue of old samples mixed with the vacuum oil.
Remedy: Please change vacuum pump oil.

B. It can be caused by too widely opening of ballast valve, and there is a leakage in the vacuum line.
Remedy: close the ballast valve by turning to the right to eliminate leakage in vacuum line.

C. It can be caused by failure of exhaust filter.
Remedy: Please replace the exhaust filter.

Chapter 8 Warranty and contact information

8.1 International Warranty

The warranty period starts on the moment the unit leaves the production facility (the date of invoice). After this date three year warranty on the parts is valid. During first three year component parts proven to be defective could be send to your local dealer and will be covered by the first three year warranty on parts only. Expendable items, i.e., glass, filters, pilot lights, light bulbs and door gaskets are excluded from this warranty. MRC shall not be liable for any indirect or consequential damages including, without limitation, damages relating to lost profits or loss of products.

8.2 Conditions and terms of sale

All prices are ex works from MRC Warehouse in Israel, Asia excluding insurance, seaworthy packing and customs duty. Effective prices are those valid on date of confirmation of order. All specifications mentioned in the price list are based on 220 V / 50Hz power supply. Continuing research and improvements may result in specification changes.

8.3 Contact information

In case service of sales back up is needed please do not hesitate to contact our dealer in your area, or our technical and service department located in ISRAEL:

MRC Co., Ltd.
Address: HAGAVISH 3, HOLON, ISRAEL
Tel: 972-3-5595252 Fax: 972-3-5594529
Email: mrc@mrclab.com

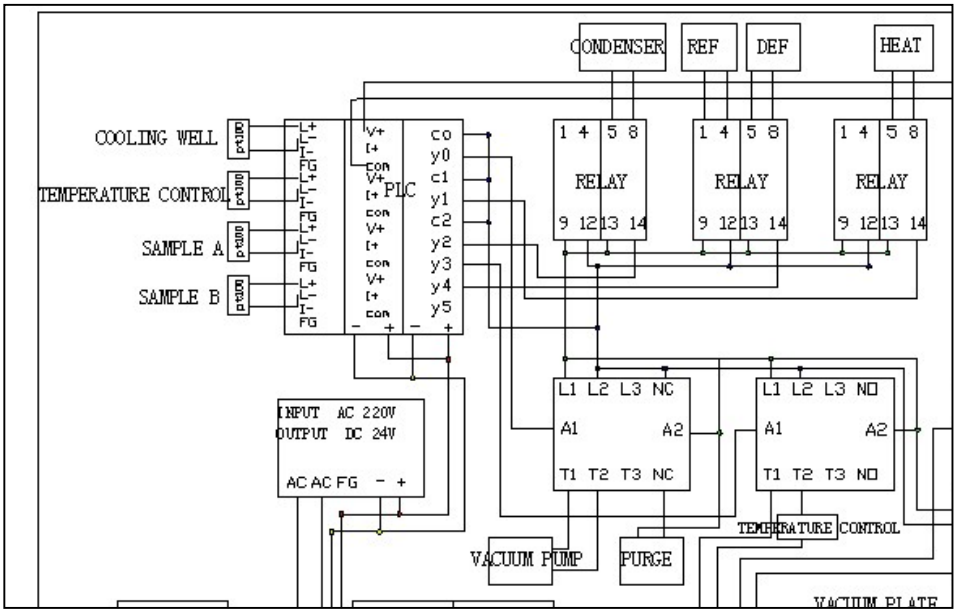
Appendix A: Technical Specification

Model	FD5-3 FD8-3	FD5-4 FD8-4	FD5-5 FD8-5	FD5-6 FD8-6	FD5-8 FD8-8	FD5-10 FD8-10	FD5-12 FD8-12	FD5-15 FD8-15	FD5-19 FD8-19	FD5-25 FD8-25
Compressor (-58℃)	7/8 HP	7/8 HP	1 HP	1 HP	1 HP	1.5 HP	1.5 HP	2 HP	2 HP	3 HP
Compressor (-86℃)	2x7/8 HP	2x7/8 HP	2x1 HP	2x1 HP	2x1 HP	2x1.5 HP	2x1.5 HP	2x2 HP	2x2 HP	2x3 HP
Max. Ice Capacity	3L	4L	5L	6L	8L	10L	12L	15L	19L	25L
Ice condenser performance	2L/24h	3L/24h	3.5L/24h	4.5L/24h	5.5L/24h	8L/24h	10L/24h	12L/24h	14L/24h	20L/24h
Ice condenser Ult-Temp.	-58℃									
Ice condenser Ult-Temp.	-86℃									
Pump suction capacity	120L (Bench Top) 162L (Vertical Type)	120L (Bench Top) 162L (Vertical Type)	120L (Bench Top) 162L (Vertical Type)	162L	162L	200L	200L	200L	250L	340L
Controller	B Type									
Pump Ult-Pressure	$2x10^{-4}$ Torr									
Deforsting System	Hot gas solenoid system or heater defrosting system									
Gross Weight (Kg)	70/123	70/123	70/123	123	123	123	123	150	150	150
Bench top/ Floor Type	Bench top/ Vertical Type	Bench top/ Vertical Type	Bench top/ Vertical Type	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical
Electrical Requirement	220 V, 50/60 Hz, single phase							380V	380V	380V

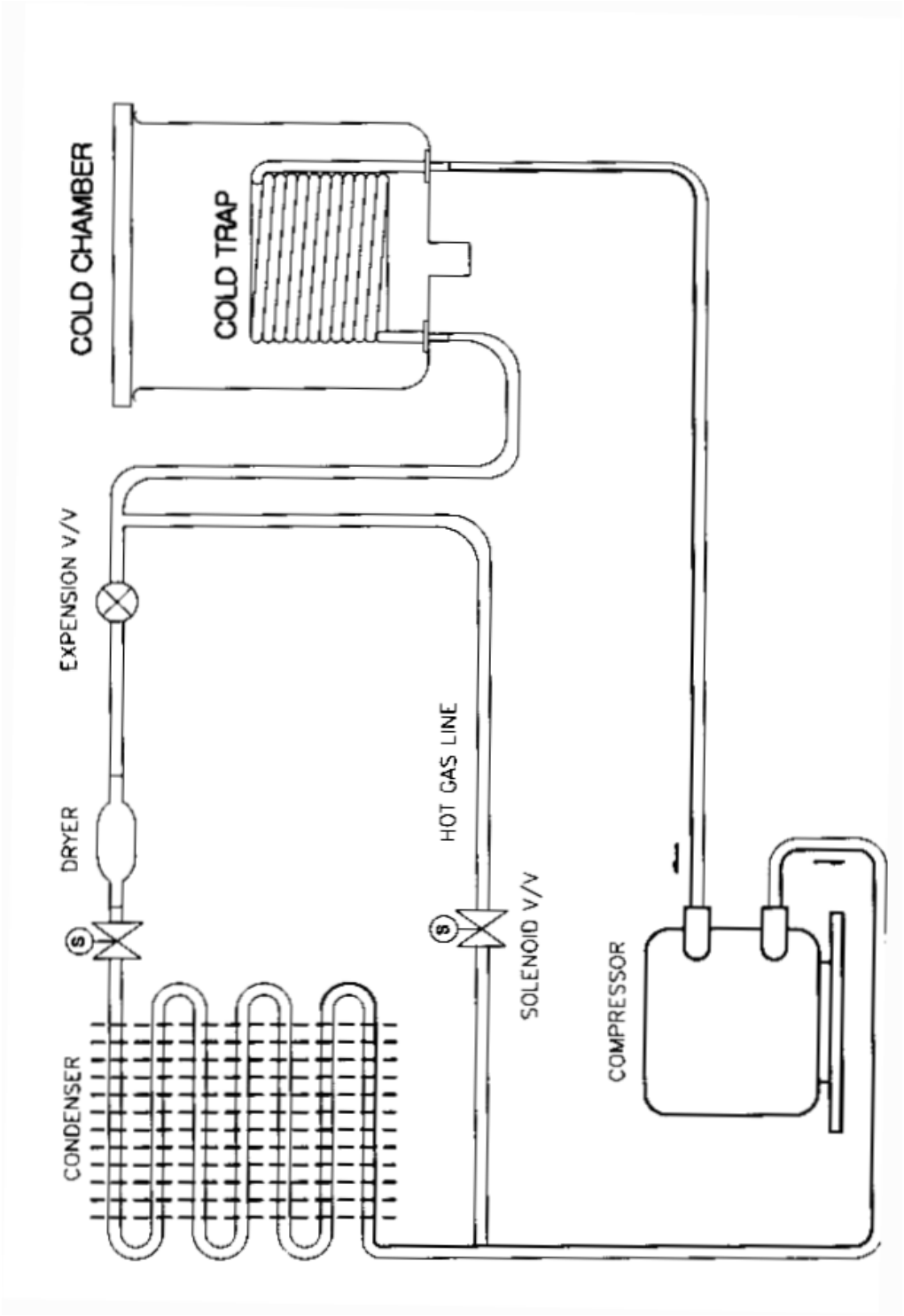
Explanation:

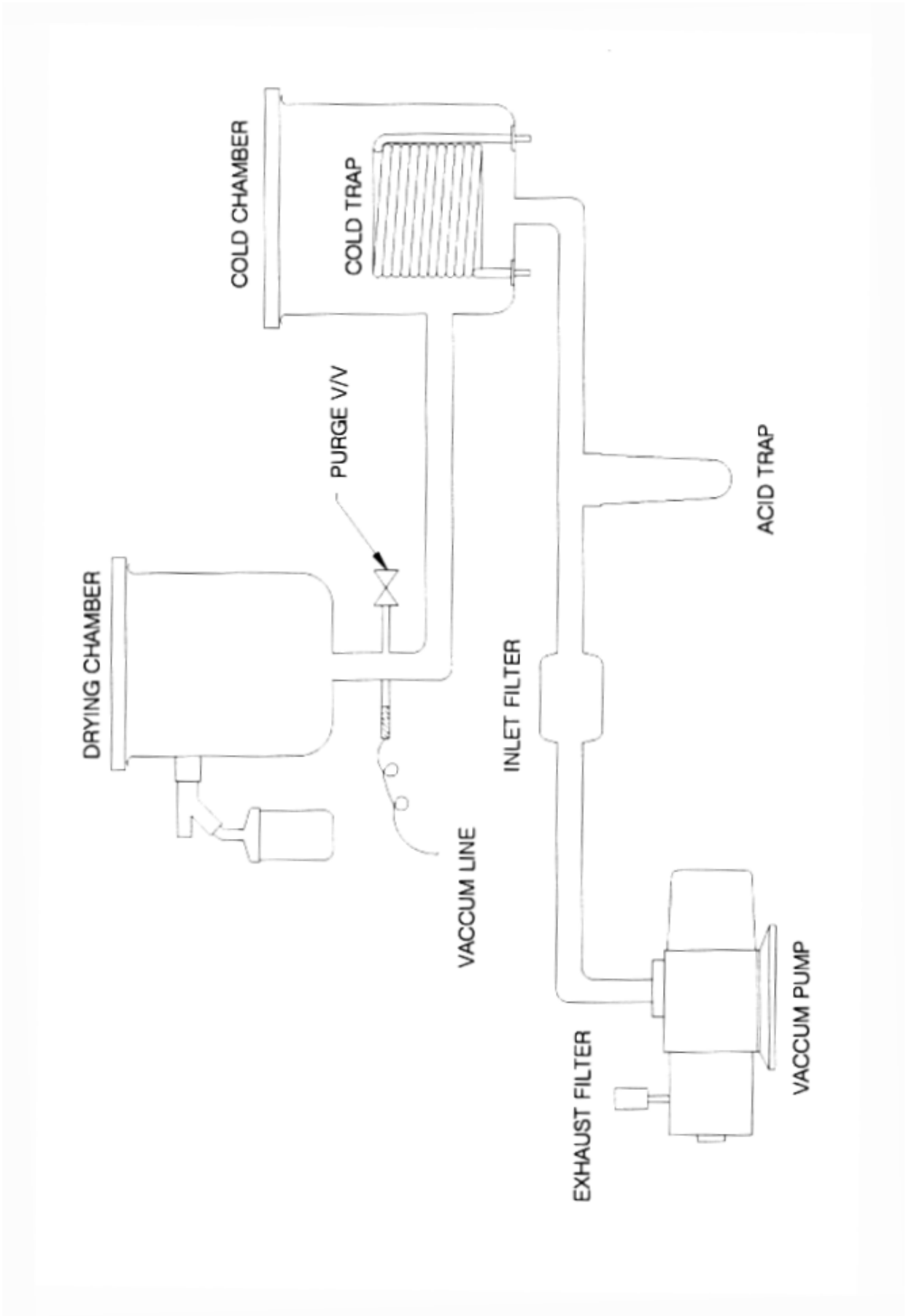
FD 5-6: FD-Freeze Dryer; 5-Ice condenser temp. -58℃; 6-max ice capacity: 6L
FD 8-6: FD-Freeze Dryer; 8-Ice condenser temp. –86℃; 6-max ice capacity: 6L
Three kinds of controllers are available: B type, T type, P type.
Freeze Dryer with a capacity of 15L, 19L, 25L can be used for industrial batch process.

Appendix B: Refrigeration Drawing



Appendix C: Principle of Refrigeration





Appendix D: Vacuum System